A Novel Biomechanical Model for Hip Microinstability

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Introduction

Hip microinstability is a condition characterized by increased femoral head motion within the acetabulum. It is caused by an insufficient anterior capsule.

Sources:
- Ligamentous laxity
- Post-traumatic
- Iatrogenic (failed or incomplete capsular closure)

Symptoms:
- Anterior groin pain
- Worse with extension and external rotation
Goals:

1. Develop biomechanical model of hip microinstability
2. Determine importance of capsule and labrum on hip stability

Hypothesis:

1. Reproducible cadaveric model for instability possible
2. Both labrum and capsule synergistic in controlling femoral head motion
Methods

12 hips from 6 cadaveric pelvis (matched pair)
• Age <50, no OA or dysplasia

Use Instron™ machine & motion capture system for data collection

Specimen preparation
• Stripped of soft tissue down to capsule and bone
• Set in neutral position using a custom jig

Cut potted, and positioned on Instron for testing
Methods

**Capsular laxity** was created using the Instron to stretch the hip capsule

- The hip was brought to maximum extension and rotated to 30 Nm per 100 cycles
- Then, specimen cycled to position of maximum ER at 100th cycle, and submitted to 1000 cycles

**Testing conditions**

- Intact state
- Labral insufficiency (radial + chondrolabral tear)
  - Labral insufficiency was created through a limited capsulotomy under direct vision.
- The capsule was repaired
Results

Capsular stretching significantly increased the hip arc of rotation.
Capsular stretching also increased femoral head translation.
The combined model (capsular laxity + labral insufficiency) resulted in more motion than either states in isolation.
Unlike prior static testing models, capsular laxity was created via a controlled cyclic stretching protocol after venting of the joint, and this protocol caused a significant increase in femoral rotation and femoral head displacement.

In a biomechanical model, increased motion and rotation could be seen if a small inadvertent puncture of the capsule happened during dissection or stretching of the capsule. By demonstrating differences between the vented and laxity states, this model shows that the observed results are due to the stretching of the capsule.
Discussion

• Previous biomechanical studies on hip microinstability reached similar findings

• Jackson et al. reported an increase of ER from 26.3° to 30.9° after the creation of the model

• Han et al. reported an overall increase of 4.1° in ER and 3.1° in IR in all positions of flexion examined. They also found an increase in femoral head translation, with the largest occurring during IR, with 0.9 mm of additional medial translation in full extension and 0.95 mm of lateral translation in 90° of flexion
Conclusions

The hip microinstability model was validated

- Increased ROM with cyclic stretching of capsule
- Capsular laxity caused increased femoral head motion

Labral tears cause more motion in the setting of capsular laxity
References